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40 PURPOSE

The purpose of this chapter is to outline the objectives of monitoring over time; i.e, monitoring range trend. Are conditions stable, improving or declining? Also included is guidance on monitoring at broader, i.e, landscape scale.

41 – TREND MONITORING OVERVIEW

Monitoring of the resources and uses on rangelands is a part of the total range management job. The analysis and planning job is complete when the goals and objectives of the Forest Plan, Rangeland Project NEPA decisions, and Allotment Management Plans are being achieved. The focus of this section is on monitoring range trend.

Monitoring is a sampling process used to determine the state or condition of a resource or area. Trend monitoring is the process of assessing the change in some attribute or attributes over time. Measurable attributes of range condition include both biotic (vegetation) and abiotic (soil, water) components. Trend is important to determine whether desired conditions are occurring, to determine whether the ecological state of the rangelands is moving towards or remaining within an acceptable state, and to help set management priorities.

As with determining the current, “snapshot” state of the environment (Chapter 20), assessing the ecological state over time may be described as the gathering and interpreting of sufficient information so the manager knows what is happening on the ground and why it is happening. The objective of monitoring is to test, under actual use, the predictions made during the planning process. Follow-up is done specifically to determine if the management program is accomplishing the management goals and objectives established for the rangeland management unit.

Monitoring information provides critical feedback to adapt management in efforts to achieve desired results. Thus, developing a monitoring plan that addresses key questions and implementing that plan are important steps in the management process. Monitoring results should be used to change actions as appropriate (adaptive management). Give considerable attention to monitoring during the years immediately following implementation of the rangeland project decision/ AMP and during times of increased system stress (such as drought and weed invasions).

No plan is considered static and final. Goals and objectives are subject to periodic change. Environmental conditions and management efforts are dynamic and constantly changing over time. For these and other reasons, monitoring must continue indefinitely.

Whenever possible the permittee(s) should be involved with allotment inventory, monitoring and inspections. If the permittee is not involved, they should be made aware of the inspection and/or monitoring results in a timely manner. Information from allotment inspections and monitoring should be used in developing Annual Operating Instructions and updating Allotment Management Plans.

41.1 - Types of Monitoring

There are three types of monitoring:

1. Implementation monitoring verifies whether the treatment or action actually occurred. It is used to determine if goals, objectives, standards, and management practices are implemented as detailed in the Rangeland Project Decision document and/or Biological Opinion and Forest Plan. The question being answered with this type of monitoring is "Did we do what we said we were going to do this year?" Annual vegetation monitoring on key areas is covered in chapter 30.

2. Effectiveness monitoring is monitoring that verifies whether objectives were met. It is used to determine if management practices are effective in meeting Forest Plan, NEPA, or biological opinion goals, standards, and objectives. The question being asked is "Did the management practices do what we wanted them to do over time, or in other words - did they meet the objectives?" Example of monitoring actions would include measurement of vegetation to determine if it was moving toward the identified desired plant community on benchmark sites, including noxious weed infestation areas if present. Trend monitoring of benchmark areas is covered in this chapter.

3. Validation monitoring is used to determine whether the information used to determine standards, guidelines, and objectives is valid and correct. The question being asked is "Is there a better way to measure meeting Forest Plan and rangeland project decisions goals and objectives?" This is typically a research answered question.

41.2 - Monitoring Sufficiency

Perform sufficient monitoring to accomplish the gathering of data and information needed for interpretation of long-term trend determinations for desired conditions and to implement adaptive management changes. This will involve identifying and validating first the management questions and then the subsequent sampling question required to assure that sampling is appropriate and and rigorous enough to answer the questions and be statistically valid. Additionally, a big factor in the sufficiency and cost of monitoring is: How often? Reducing monitoring frequency can significantly reduce costs. Is is necessary to monitor each year? Identifying the monitoring thresholds or amount of allowable change in the sampling questions will help to determine the required frequency and intensity of sampling.

41.22 General Recommendations on Objectives and Sampling*

Set management objectives for treatments during the planning process. A management objective is a clear description of a measurable standard, desired state, threshold value, amount of change or trend that you are striving to achieve for a particular population or habitat characteristic; it may also set a limit on the extent of an undesirable change. There are several components required for complete management objectives:

1. Species or habitat indicator. (Indentifies what will be monitored)
2. Location (specific geographic area)
3. Attribute (aspect of the species or indicator—e.g. size, density, cover)
4. Action: the verb of your objective (e.g. increase, decrease, maintain)
5. Quantity/status: measurable state or degree of change for the attribute (increase, decrease, limit, maintain)
6. Time frame: the time needed for management to prove effective

   For example: Increase the vegetation cover in the treated high severity burn areas of the N. 25 Fire to at least 30% in year 1 after the fire.

Set sampling objectives for the treatments. A sampling objective is a clearly articulated goal for the measurement of an ecological condition or change value. When you plan to monitor using sampling procedures, sampling objectives are a companion to management objectives.

Using the above management objective, an appropriate sampling objective might be:

We want to be 95% confident that the cover estimates are within 20% of the actual cover.

Given this objective, we want to be able to determine cover in the treated area of ± 20% or from 24-36%.

Select a few things to measure well and use the lowest level of sampling necessary to meet objectives. Data kleptomania is a real concern (getting WAY more than you really need)!

Think about the collection, entry and analysis of the data at the start (design field forms with these things in mind)

Work with research to rigorously test some of these methods/treatments over various years and locations. Get help on methods, analysis and design.

*Much of this discussion comes from the class: "Vegetation Monitoring in a Management Context"

41.3 - Monitoring Plan

Monitoring must be very specific, well thought out, and carefully targeted. Each Allotment Management Plan shall include a detailed monitoring plan. The Plan shall be consistent with applicable AMP NEPA decisions, Forest' budgets and resources.

Select which attributes to monitor and at what level of intensity after reviewing the project level NEPA or Forest Plan prescriptions. This starts at the original scoping efforts and the issues, concerns, and opportunities that drove the analysis and selection of a preferred alternative. The statement of objectives is designed to achieve the desired state within a specific time frame and location. They must be sufficiently specific and measurable to allow for (and guide) monitoring and they should clearly tell what the monitoring needs are. Some potential questions include:

1. Is vegetation status at or moving toward functionality with trend being maintained or improved?

2. Are rangeland resource concerns being addressed in order to achieve desired rangeland conditions?

3. Are other resource concerns being adequately met?

The rangeland project NEPA decision should provide direction for monitoring and that direction must be results oriented and specifically targeted in the monitoring plan. The rangeland monitoring plan should:

a. Identify specific vegetative or other attributes to monitor. Potential categories include: canopy and/or ground cover, density, nested frequency (plant abundance), % bare ground and presence of noxious weeds.

b. Identify the threshold values or % change values of the attributes. What constitutes an important change? How many samples are required to detect this change?

c. Develop specific monitoring schedules and techniques. Be realistic in terms of what should be done and what can be done within the constraints of need, time, and personnel (funding). Monitoring protocols selected must be consistent with those identified in this Handbook. Monitoring locations are selected based on these protocols.

d. Identify who is actually going to do the work.

e. Identify specifically how and where information is going to be stored into corporate resource data bases, who will analyze it and when.

The following describe Regional methods used for long term trend monitoring. Some of the methods are mandatory on all rangelands, such as selection and description of benchmark areas, repeat photography sites, and long-term trend determination. Selection of monitoring procedures and protocols are dependent on the attribute being monitored and the level of intensity determined necessary. Select the protocol used for the attribute being monitored. Use point frames for quadrats for ground cover, line intercept for taller shrub cover, plant counts by area for density, and nested frequency for plant abundance and/or composition.

Interagency Monitoring Handbooks may supplement this Regional Handbook.

42 – Benchmark Areas

Benchmark Areas or Key areas on rangelands shall be where observations and studies are made and where information gathered can be extrapolated to non-sampled areas. Benchmarks must be representative of the rangeland that will be sensitive to changes in rangeland management, livestock management, wildlife management or other important management activities. Data extracted from these areas will serve as a comparison with other areas under treatment. (Examples of treatment include livestock grazing, fuels reduction, and introducing biological controls of invasives.) Benchmark also serve as a way to track changes in the environment not related to treatment. The number of benchmark areas required will depend on the complexity of the soil, vegetation, topography, management objectives, and use the area. As a guide, there should be at least one benchmark area for each rangeland management unit. Large rangeland management units may need two or more benchmark areas, depending on the vegetation complexity and/or management scenarios. Benchmark studies should be used to determine if the goals and objectives of the Standards and Guides of the Forest Plan and AMP are being met.

Benchmark areas may need to be changed or new ones selected when vegetative or abiotic conditions or rangeland use is significantly modified. If this occurs, do not discard the old information as it may prove valuable in future interpretations and analysis.

Long-term (often several years between readings) trend studies shall be placed on benchmark areas. Sufficient benchmarks should be placed to directly correlate annual measurements with measured trend. Benchmark areas shall be described and delineated according to the criteria below. Select a date for installation of trend studies when plant species are easily identified. Study measurements must be comparable at different points in time. Future measurements should be made within two weeks of the previous phenological stage for comparability purposes.

42.1 - Selecting Benchmarks

Benchmark areas should be selected and approved by the most experienced and qualified rangeland management personnel available, and agreed upon or coordinated with permittees and other interested agencies, individuals or groups. Benchmarks should be permanently marked on the ground, their location determined using GPS, and delineated on GIS maps. They should be located where the ecological situation is well understood and selected only after a careful evaluation of current use patterns. They should not cross ecological types. Screen old Parker Three Step clusters or other long term transects for appropriateness as benchmarks. Many of these clusters are properly located and can provide consistency with updated monitoring data. Keep Parker Three Step cluster data in allotment files for reference.

Appropriate interdisciplinary team personnel should be involved depending on resource issues. The team should be involved with the rangeland management specialist in the selection of benchmarks, selection of the types of studies, methods to be used, and the monitoring of the various attributes pertinent to their area of expertise. Benchmarks should be located on a site that is representative of one of the predominant, suitable range ecological types in the monitored unit. The need for monitoring riparian vegetation should be considered when selecting benchmarks. Avoid unique situations which may not be comparable to the rangeland management unit; and areas along fence lines, salt grounds, water developments, unsuitable and inaccessible terrain.

Select a rangeland site that will be sensitive to changes in management or administration of the area. The ecological situation should be understood and the attributes of the management goals and objectives monitored must be present on the area. Badly depleted or shallow soil areas may not be capable of responding to management changes and hence may be poor barometers of expected change if in a new stable ecological state.

Benchmark data should be captured and stored using RangelandPC. Use the corporate Site and Setting Form to document the benchmark for inclusion into corporate data bases (http://fsweb.ftcol.wo.fs.fed.us/frs/rangelands/inventory/sitesetting-form.php).

43 – APPROVED MONITORING METHODS

Rangeland monitoring should be an open, collaborative process jointly accomplished by the Forest Service, rangeland permittees, and other rangeland users/interests. Monitoring is the day-to-day routine in collecting data on rangelands and should not be a sporadic task-force assignment. Information gathered should meet long-term objectives.

Long-term trend monitoring tracks rangeland changes over time and the achievement of goals and objectives that are stated in the project decision and Forest Plan. These studies should:

1. Be tied to a specific area and ecological type with results that can be extrapolated.

2. Have specific measurements that are repeatable and quantifiable.

3. Be interpreted to assess factors that cause and affect change.

4. Be a reference point for historical perspectives.

Use the Table in Chapter 20 of this handbook as a guide to refine monitoring objectives by selecting the appropriate scale and intensity of analysis. Once you have identified the scale and intensity, specific trend monitoring methods are described in the Section 44 that follows. These include:

1. Photograph points – for pictorial vegetative and watershed trends and representations.

2. Nested frequency – for plant species abundance.

3. Ground or canopy cover – for watershed protection/stability and rangeland functionality.

4. Line intercept – for taller shrub cover.

5. Plant density - for number per unit area and condition of shrubs and forbs.

6. Riparian protocols are given in RMRS-GTR-47 "Monitoring the Vegetation Resources in Riparian Areas" Winward, April 2000, (http://fsweb.ftcol.wo.fs.fed.us/ftp/pub/staff/rangelands/docs/protocols/riparian/GTR_47.pdf) and modified by Cole-Ritchie et.al., 2003, and by riparian scorecard methods (Riparian Classification and Status Guide for the Fremont, Ochoco and Lakeview BLM.)

Old Parker Three-Step loop-frequency trend transects should be screened and either converted to nested frequency, canopy cover, ground cover, and/or shrub density studies, a permanent photo point, or dropped entirely. The photographs and data collected through the Parker technique shall be kept permanently in a corporate database for future reference and comparisons.

Discontinue collection of Parker data as a means of long term trend monitoring when an appropriate protocol for replacement is determined in the monitoring plan.

44 - LONG-TERM RANGELAND TREND DETERMINATION

44.1 – Measuring And Interpreting Trend - General Considerations

Trend is a quantitative assessment of change based on repeated measurements at the same location over time of the kind, proportion, and/or amount of plant species and soil surface properties. It provides quantitative data for interpreting the direction of change, often before it is detectable by repeated photographs over time. Trend provides feedback to indicate if management objectives are being reached. Under adaptive management processes, if progress is unsatisfactory as described in the rangeland project decision/ AMP, modification in management practices may be needed after information is evaluated.

Trend in a desired condition attribute when compared to management objective(s), refers to the change in an attribute at a particular location. The direction of trend is based on whether the changes in vegetation and soil conditions are desirable or undesirable for specific management objectives. Trend of soil surface conditions is interpreted from evidence of accelerated soil erosion.

Because of the variation in trend interpretations, the type of trend must be specified as to a desired condition. Express desired condition as described by an ID team. Describe trend in desired condition as "meeting", "moving toward", or "not meeting".

Planning discussions concerning trend should speak toward the desired condition.

Early detection of trend involves some risks because vegetation properties naturally fluctuate widely within and among years because of climatic variability and other influences. Consider these normal fluctuations when determining trend. Sampling error further confounds the problem of detection of trend. Nested frequency is particularly valuable in detecting change since yearly fluctuations in climate and other influences do not affect frequency as much as some other measures (cover for example).

Many techniques are available to monitor trend and each has pros and cons. A review of these techniques leads to the conclusion that plant production, cover, and density are not reliable measures of trend, particularly for herbaceous species due to the potentially wide within- and between-year fluctuation of these attributes.

Because of the complete renewal of above ground growth annually, the varied growth forms and phenology differences of individual species, no single measure of herbaceous plants is best for determining trend. Each method has deficiencies. Plant production and foliage cover data are highly variable, both seasonally and annually. A few major species will also control production and cover data. Basal cover is more stable, but difficult to measure for many species. Plant density is a difficult parameter to sample adequately because of varied growth forms and, at times, the difficulty in identifying what constitutes an individual plant.

Frequency measures the unit-area stocked through presence of a plant in an area. Frequency data are objective, repeatable, and statistically reliable. As with density and basal area, frequency is rather insensitive to seasonal and yearly variation, a desirable attribute when monitoring long-term vegetation trend. Frequency changes with a change in plant dispersion as well as with a change in plant density (dispersion is an important ecological attribute, it is desirable to have undesirable species clustered and desirable species scattered because the scattered condition gives a species greater opportunity to dominate the site). Frequency is the only method of sampling that integrates dispersion and density in a single measurement.

For trend interpretation, frequency data generally are interpreted by analyzing differences in frequency of individual species over time on a specific ecological type. Key species may be selected for dominance, desirability for certain uses, or indicator value in the community. Although frequency may not be consistently related to density, basal cover, or distribution pattern, changes in trend may be inferred if change in frequency occurs between two sampling periods. An increase in a plant's frequency indicates that new individuals have become established. (Note frequency is assumed to increase only when a plant is rooted within a certain quadrat size. Overhangs into a smaller quadrat could suggest increased size of existing plants. If both rooted nested frequency and cover are used we can then account for recruitment and for increased size (cover) of existing plants.) This change in a preferred species is interpreted as being desirable or showing a moving "toward" trend and a similar change in undesirable species indicates a moving "away from" trend. If individual species of interest are recorded by categories, for example, newly established (exclude current seedlings), mature, and old, interpret the change in frequency as to how the age classes within species are undergoing change.

Frequency may be used to indicate a real change in vegetation but it cannot be interpreted to indicate a specific amount or the specific property of a species unless additional information is available. Frequency will not interpret whether the change is in density or basal area. Frequency can be used to “see” changes in spatial pattern in a sample area if occupied quadrats are interpreted for changes over time. The rangeland manager must interpret what has happened. Frequency is appropriate and reliable to detect change in the role of species in a community.

Frequency cannot be efficiently or meaningfully used in all vegetation types. It is more meaningful in perennial grasslands and for interpreting change in the herbaceous and small shrub component in shrub-grass vegetation. For some forb dominated sites, such as wyethia, balsamroot, and geranium, density may be a better trend measurement. For large woody plants, canopy cover, density, and age and form class may be the best basic measurements to monitor trend.

In cases where a vegetation classification or scorecard are needed, seriously consider adding the collection of areal percent cover data (as with Daubenmire frames or similar method). Although this means extra work and data maintenance, it is necessary to develop a classification.

Soil surface condition is obtained along with frequency by fixing points on the sample frame to record hits on bare ground, litter, gravel, total basal cover of vegetation and other characteristics of the soil surface. However, this method will not usually adequately sample basal cover of individual species because of insufficient number of observations.

In summary, frequency, density, and basal area are relatively stable attributes of herbaceous plants; whereas, herbaceous cover and weight are "moving target" type attributes for which community description and trend are confounded with stage of growth, utilization and weather conditions when measurements are repeated over the years. Density is nearly impossible to measure accurately for some herbaceous species, and basal area is realistic only for bunch type species.

44.11 - Equipment List for Conducting Trend Studies

1. Steel fence post and post driver for marking the study location.
2. One-hundred-foot tape graduated in tenths.
3. Two tape anchoring rods (5/8-inch steel pegs 2-1/2- to 3 feet long).
4. Two 7-foot lengths of 1/8-inch parachute cord.
5. Angle iron stakes - 18 to 24 inches long with 3/4- to 1-inch flange or
6. 1/2- to 5/8-inch reinforcing rod.
7. Plumb bob.
8. Two-pound hammer.
9. Pliers.
10. Tripod.
11. Digital camera and media card.
12. GPS unit with operational compass and altimeter.
13. Clipboard.
14. Range Ecosystem Analysis and Monitoring Handbook.

15. Plant identification books.

16. Two 6-foot folding wood or metal carpenters rulers (for making 3-foot by 3-foot plots).

17. Crescent wrench (for turning angle iron stakes).

18. ID card (kraft folder material, chalkboard or whiteboard).

19. Two binder clips or bulldog clips (for holding corners on the 3-foot by 3-foot plots).

20. ID card holders.

21. Felt-tip pen, chalk or whiteboard markers.

22. Personal Data Recorder (PDR) with protocols.

23. Calculator (in PDR).

24. Nested Frequency Frame.
    50cm by 50cm-----------------------19.69 by 19.69 inches.
    w/nested 25cm by 50cm---------------9.84 by 19.69 inches.
    w/nested 25cm by 25cm---------------9.84 by 9.84 inches.
    w/nested 5cm by 5cm-----------------1.96 by 1.96 inches.

25. Plant press (optional field equipment) or Zip lock style plastic bags (for collecting specimens).

26. Study plot location tags plus nails.

44.12 – Electronic Forms Needed on Personal Data Recorders for the Various Study Methods

The following forms are required for each of the individual study methods. Use the corporate forms to document on your personal data recorder for inclusion into NRIS-Terra.

1. Nested Frequency/Shrub Density Method/Ground Cover. http://fsweb.ftcol.wo.fs.fed.us/frs/rangelands/inventory/nested-frequency.php

2. Line Intercept Method. http://fsweb.ftcol.wo.fs.fed.us/frs/rangelands/inventory/line-intercept.php

3. Canopy Cover. http://fsweb.ftcol.wo.fs.fed.us/frs/rangelands/inventory/cover-frequency.php

44.13 - Accuracy, Precision, and Probability Statements

Regardless of the type of data collected to evaluate vegetation change, interpretation should be supported with statistical analysis. Vegetation parameters are estimated by measurement from sampling. Accuracy concerns the nearness of the estimated value to that of the actual value. Precision refers to repeatability of the sample estimate. Probability is the percent of time one would except to see a given result in a sample set. High precision suggests a high degree of accuracy, but this is not necessarily the case when dealing with vegetation.

Precision and probability statements are functions of sampling intensity and population variability. High precision in vegetation sampling is generally very costly to obtain because of the large number of samples required. For trend analysis a compromise between sampling cost and the risk of an incorrect interpretation of data suggests that a precision of + 20 percent of the mean at a probability of 80 percent should be the minimum acceptable level. Increasing the probability to 90 percent would require an increase in sampling effort of about 50 percent. However, specification of an adequate level of statistical reliability of data will greatly enhance acceptance of related decisions.

44.14 - Interpreting Trend Data

Measured or observed changes in kind, proportion and/or amount of plant species on a site or in soil cover characteristics are interpreted as changes in trend. To decide if a change in management is needed to reverse undesirable trends or to accelerate desirable ones, the causes of trends need to be established. Annual weather and growing conditions should be emphasized in trend interpretations. The following are guidelines for collection and interpretation of trend data:

44.14a - Interpreting Trend at One Location

Minimize differences in measurements obtained at different dates on the same location because of sampling error, personal bias or lack of adequate training. The sample area should not involve more than one ecological type and sampling design should account for heterogeneity in plant pattern, topography, and microclimate.

44.14b - Interpreting Trend in a Management Unit

It is rarely feasible, nor is it necessary, to obtain a statistically valid sample of an entire rangeland management unit for trend monitoring purposes. Each monitoring location should be carefully selected with specified objectives developed for each location. Do not combine data from different sample locations until after interpretation of each location is made and then only if it is certain no information will be lost. The overall trend on a rangeland management unit cannot be determined by averaging trend data from various locations except perhaps under cases of extremely good or poor management.

44.14c - Collateral Data

Collection of collateral data to aid interpretation of soil or vegetation change is essential.

1. Weather data should be collected from the closest data collection station that relates to data interpretation at monitoring location. National Weather Service or Forest Service storage gauges read monthly or seasonally can be used for precipitation. Hobo gauge thermometers at selected locations may help explain extreme events.

2. Records of annual management should be maintained.

3. Observations on populations or occurrence of rabbits, rodents, insects, fire, or other disturbances also can be made.

44.14d - Frequency for Collection of Trend Data

Measure trends frequently to establish the reality of trends, the causes for them, and whether new stable states exist. This is particularly important where management problems exist but causes are debatable. Because limited resources often dictate that trend monitoring can be done only at intervals of three, five, or more years, a monitoring strategy designed to aid in accurate identification of trends and their causes is important. Following are ways to overcome infrequent measurement:

1. Select a few locations for frequent measurement. Choose a location where collateral information relative to management objectives can be obtained. Establishment of a continuous trend in soil/vegetation characteristics in relation to weather, utilization, actual use and other variables will support a more accurate interpretation of data gathered on an infrequent basis elsewhere.

2. Pay special attention to designed comparisons among trend locations. For instance, if vegetation cover is declining on numerous trend locations irrespective of the management system, it may be assumed that weather or factors other than management are responsible. However, if cover of forage species declines on an ecological type in one management unit but increases or is static on the same ecological type in an adjacent unit, a change in management is indicated.

44.15 - Trend Determinations

Trend can be determined for changes in desired ground cover, shrub cover, shrub densities, and for individual plant abundance.

Trend in individual point or plant measurements concerning specifics in the desired condition can be determined using the Chi-Square table that is in section 46.

44.16 - Trend Study Sites

Confine sampling to a single ecological type. Use sections 42and 42.1 as a guide in selecting and screening benchmark locations.

Upon selecting the study site and/or finding the previously established benchmark, document the location and any changes in reference points or status of the transect noted. Record this information on the corporate Site and Setting Form. (http://fsweb.ftcol.wo.fs.fed.us/frs/rangelands/inventory/sitesetting-form.php).

44.16a – Photographs

Photographs are an important part of the study and should portray changes taking place on the ground. They should provide a good visual image of the site and help to relocate the study for future measurements.

As a minimum, a general view and a close-up photo of the 3-foot by 3-foot plot should be taken before taking any measurements. Take photos from the 100.0 mark on belt 1 or at the best suitable point. Use a digital camera that allows the setting of focal length. This will provide a means to better reproduce the photos in later visits. Additional photos may be taken if desired. Permanently mark photo points and GPS. Follow procedures in Ground-Based Photo Monitoring (Hall 2001), and related documents (Hall 2002a, b).

44.17 - Documentation and Maintenance of the Study Site

Study sites should be located and sufficient instructions and diagrams provided so that it can easily be relocated.

1. Make a GIS map that includes a GPS point/area the study site. Include the positioning of individual transect lines. The GIS package should include a map, GPS points, photography, audio, and data with analysis. The corporate GIS system may be used that is easily shared through an .html document on a web page, e-mail, or compact disk and exported into corporate databases.

2. Take a general view digital photograph of the study site, along with individual transects, from referenced GPS points.

3. The study location should also be identifiable on the ground. Use steel posts or other natural features to permanently mark the location. In the event the witness marker is destroyed, locate a substitute and make appropriate notation on the form describing the change. Replace

missing transects stakes at the time the study is re-measured. Recorded GPS data should document the study site.

44.18 - Species Identification and Collection

Properly identify plant species and use only approved species symbols. If the symbol is inaccurate or incomplete, it may be difficult to interpret the data. For example, Artr could be misinterpreted as Artemisia tridentata when actually Artemisia tripartita was intended. Use the PLANTS database for species names and associated codes.

Include a list of the species present in the immediate area in each long-term trend study folder to facilitate identification and consistent use of species symbols. Include both scientific and common names. In addition, make an individual plant collection for each study. The use of plant collections on 5- by 7-inch cards makes them easy to store in the study folder and the carry into the field the next time the study is read.

When a plant cannot be identified in the field, it should be given a descriptive name or a number. Collect, press, and identify a specimen. Once the plant is identified, correct the data sheets, assuring that all information is complete.

44.19 - Requirements for a Completed Trend Study

The study is not considered complete until the following items have been addressed:

1. Properly-collected field data.

    a. Obtain a representative sample of the site.

    b. Complete all forms on a personal data recorder for data inclusion into NRIS-Terra.

    c. Label all digital photographs and correlate with .GPS electronic file.

2. Assimilating, Binding and Filing Data. The final step in conducting trend studies is making sure the information obtained is available for future references. File the data in the corporate NRIS-Terra database and supplement on a corporate electronic drive. Each electronic file should contain:

    a. Completed data including GIS with map, GPS'd digital photography location, and description of the study location. Precise written documentation of the location is recommended until observer verifies that GPS locations are indeed precise (through post-processing).

    b. Completed summary.

c. Evaluation and interpretation of the data (where more than one measurement is available).

d. Digital photography archived in database.

e. Any narrative information concerning previous grazing impacts, fires, insect infestations, or other factors that would influence the condition of the study area.

Prepare two complete sets of electronic data. Retain one copy in the corporate database NRIS-Terra; store the second copy electronically in a safe location on a safe media. If necessary, work with Regional Data Resource Management personnel to accomplish this.

44.2 - Photographic Records

44.21 - Taking and Maintaining Digital Photography

Occasionally, the data collected by the various sampling techniques may not portray a visual image of the changes in the vegetative and soil conditions. Photographs (stills and video) can supplement data and serve as a valuable tool in determining and/or interpreting trend. As with the collection of data, the quality of the photographs is very important. Data may also be collected at the time photo point work is accomplished for a more interpretive result. Experience has provided two basic truisms:

1. Photo reference is generally of greatest value in visualizing and understanding current conditions and change over time (trend) of vegetation.

2. Photography is easier and faster than data collection (sampling) and has the potential to provide periodic assessment of a rangeland at a relative low cost.

44.22 - Obtaining Quality Digital Photography

1. Determine your objective before you begin.

2. Search to find locations that exemplify the resource conditions that are desired to be portrayed.

3. Carefully choose the precise spot from which various scenes are available to the view of the camera.

4. Locate a permanent stake in the ground and document the location.

a. GPS photo point.

b. Know the capabilities of your camera and how to use of it. Use digital cameras that allow the selection of focal length. Note this information.

c. Orient general views with 25-75 percent horizon in the frame.

d. Plumb your picture! Make sure camera is held to a horizontal or vertical plane (that is, actual slope is portrayed).

e. Take all photographs after the transect line is established, but prior to taking any measurements. This procedure is particularly important where measuring of the transect or individual plots would have a tendency to trample the vegetation.

f. Use a tripod when appropriate. General view photographs can be obtained without the benefit of a tripod if the individual is experienced in the use of the camera.

g. When retaking photographs, an attempt should be made to duplicate the previous view as nearly as possible.

h. When taking the close-up photograph, focus on the center of the 3x3-foot plot or the 5-foot mark in the tape. On the general view, the camera should be focused on approximately the 50-foot mark. This will provide for a good general view while being able to read the photo identification sign.

i. When using video, video very slowly.

j. Be sure date and time stamp is turned on.

k. Capture information on camera settings after picture is taken; for example, aperture setting, exposure, lens size, etc.

l. Set the camera on tiff, raw or the highest jpeg resolution available

44.23 - Kinds and When to Apply Different Types of Digital Photographs and Other Imagery

1. General or long obliques. These photos portray the visual scenes to infinity and aid in future relocation of the photo point stake. In open country, take one picture 180 degrees from the primary general view to help relocate the camera point. A third general view will enable one to triangulate to the final plot center more readily. These photos show change in vegetation composition over time (trend), and they also portray the type of plant community, its landscape characteristics, and condition.

2. Short oblique. These photos portray plant composition and "thickness". They are valuable to show detailed plant composition, current utilization, and condition. Use a frame to highlight the specific piece of ground over time (that is, carpenter's rulers, quadrat).

3. Verticals. These are used to demonstrate spatiality of vegetation. They are best for showing spatial changes over time. Frame the vegetation with a quadrat for defining the area over time.

4. Horizontal close-up shots. These are used for plant stature. They are the best for plant identification pictures. They may be used to show utilization by placing scale and backdrop behind the plant. They may show community status and plant vigor in same manner. They are also used for individual plant identification pictures (horizontal or slightly elevated above horizontal is best).

5. Video. This imagery can provide visual scans of landscapes, study lines, riparian complexes, along with audio documentation of what is being viewed. Captured audio can greatly enhance what the video or still photography are recording.

44.24 - Number and Location of Photographs

As a minimum, two photographs shall be taken at each study site. Additional photos may be taken if desired. On established studies, the pictorial record shall be maintained as originally established. When a new study is initiated, the photographs shall be taken as described below.

1. General View Photo. Take from the 100.0-foot end of the tape or at the best suitable point along the tape and in the direction that views a major portion of the tape. Center the tape in the photo, and if feasible, approximately 1/4 of the general view photo should contain skyline. This is especially important to assist in finding the study site during future measurements and subsequently locating the stakes and or relocating the stakes in the event they are missing.

2. Close-up Photograph. Take from the 100.0-foot stake in the direction of the general view photo. An exception is where a camera point has already been designated, as would be on the photo-plot transects. If the close-up photograph is located at any other point on the transect, it must be adequately marked with a GPS point so that it may be easily found and retaken. Focus on the center of the 3- by 3-foot or the 95-foot mark on the tape; ensure that none of the plot corners are left out of the photo and that the identification card is legible. Avoid shadows in the photo.

44.25 - Digital Photographic Equipment

Use a digital camera with a minimum of 2.1 mega pixels in size, or a digital video camera with a minimum of 700 zoom that has the capability for capturing and transferring the audio to the tape. Use only digital cameras set on the highest jpeg setting or higher and that have the capability to program in the focal length. It makes sense to designate a focal length for all photos for consistency. Many digital cameras have a mode that can be programmed so that the ASA and focal length are the same each time. With a film camera, this might be noted as a 35mm SLR with a 35mm lens. With digital cameras, the use of a 35mm lens setting would provide for a fairly wide view. Also note that the lowest ASA setting practical will provide the clearest photo. Also, the format of the picture should be consistent eg. Jpeg, tiff, raw etc. Jpeg, in particular can result in photos of low quality if the camera is not set to the highest quality jpeg setting. Become familiar with the camera before going to the field and do not use a camera that is not working properly. Take extra batteries, filmcards, or videotape to the field.

44.26 - Identification of Digital Photography

Properly identify all permanent record photographs. Use the corporate Site and Setting Form to record information. Each photograph could be identified with the use of an ID card. A permanent sign may be developed for each study. These are recommended because reflection from the sun can result in overexposed prints or produce a blurred ID sign. Black board signs may also be used and reused. Display the following information on the ID card in 3- to 4-inch letters.

1. District Name or Number.

2. Rangeland Management Unit.

3. Trend Study Name or Number and Transect Number.

4. Date.

Place the ID card on the outside of the close-up plot so a complete view of the vegetation and soil can be obtained.

In the general view photos, position the ID card approximately 25 feet away from and over the transect line. At this distance, the 3- to 4-inch letters should be visible in the print.

Digital photo labels identifies the photograph if the ID card cannot be read. The photographs should then be filed in the permanent electronic study folders along with the corresponding data.

44.27 - Digital Photographic Documentation

1. Label all digital photos upon downloading.

2. List the sequence of pictures at time of photography for assistance with labeling of photos later on. Follow the same sequence in your plot photography to establish a pattern to your photography.

3. Download digital photography with related GPS track logs as soon as possible so GPS links to the photography are not lost.

4. Make notes at time of photography. Capture thoughts with audio .wav files. Ask yourself - Why did I take this picture? What appealed to me? What will the picture demonstrate? Then label all photographs.

5. k. Capture information on camera settings after picture is taken; for example, aperture setting, exposure, lens size, etc.

44.28 Digital Photography Archiving

Archiving digital photography with the Regional Office is encouraged. Coordinate with the Regional range management program leader or regional ecologist. A format has been worked out for archiving photos, with specific attributes identified, compatible with NRIS Terra.. Digital photos are stored on Compact Discs (CDs), but can also be posted on the ecoshare website (www.reo.gov/ecoshare). Scanning of print photos and slides, with subsequent digital archiving, is also recommended. Because of budget and time constraints, set priorities on which photo sets you will archive. Those from long-term studies are probably the most critical to preserve.

44.3 - Nested Frequency

44.31 - Nested Frequency Method

Frequency is the number of times a species occurs in a given number of plots of a given size and considers only whether species are present or absent. It is an objective and repeatable means of collecting data for evaluating trend.

The nested frequency concept involves sampling of the vegetation with various sized plots nested within a frame. Samples are taken along randomly selected transect lines confined to a single ecological type. The data collected are a function of plot size, which in turn is related to density and distribution of the vegetation. These data serve as a basis for determining trend and can be evaluated by applying statistical procedures. Plot size is critical in frequency measures such that only frequency data from plots of the same size are comparable.

The nested frequency procedure has several important advantages over other trend study methods: (1) It is highly objective, (2) relatively easy to perform, (3) repeatable, (4) significantly more reliable than previously used methods, and (5) allows for continuity in noting vegetative changes through the use of nested plots.

It is recognized that the nested plot has apparent replication. As this is a question of statistical bias, two things overcome the possible sampling error. One is that each frame is not an independent sample; therefore, only one degree of freedom is used. Secondly, empirical analysis indicates that if a site is adequately sampled (in this case 400 nested frame samples), the final result is highly similar whether all plots are randomly tested or if a nested plot (with apparent replication) is used.

Presently, the nested frequency sampling methods provides information on changes in vegetal composition.

Use the Nested Frequency protocol and data form located at http://fsweb.ftcol.wo.fs.fed.us/frs/rangelands/inventory/nested-frequency.php.

44.4 – Ground Cover Sample Measurement

Follow ground cover measurement protocols described on page 17 of http://fsweb.ftcol.wo.fs.fed.us/frs/rangelands/inventory/nested-frequency.php.

44.5 - Line Intercept Method for Crown Canopy Cover

44.51 - Line Intercept Method

The line-intercept technique is particularly well adapted for sampling shrubs, but trees should also be tallied. Many National Forest rangeland sites will include both shrubs and trees, and the tree component should not be neglected.

Often, this method is best used for shrubs too tall for the accurate and efficient use of quadrats placed on the ground. Like the plant-density technique, this procedure can be used in combination with the nested frequency method in order to obtain additional information where shrubs are an important component of the plant community and where canopy cover is an objective for monitoring. When used with the beltline sampling layout described in section 44.16, collect line intercept data along all five beltlines in the layout. Follow protocols and use forms described http://fsweb.ftcol.wo.fs.fed.us/frs/rangelands/inventory/line-intercept.php

44.6 - Shrub Density and Age and Form Class

44.61 - Shrub Density Technique

Shrub density data may be used to supplement data collected with nested frequency or canopy cover measurements, or be used by itself depending on the monitoring goals and objectives. Do not employ it as the sole basis for determining trend but it may be used in lieu of the line intercept procedure. The technique provides plant (shrub) species density along with information on the form and age class of the various shrubs present. This information provides additional data for evaluating condition and/or trend in the shrub community, and is especially important where some form of cultural treatment has been done and/or where the shrub component is important. Follow protocols described on page 10 of http://fsweb.ftcol.wo.fs.fed.us/frs/rangelands/inventory/line-intercept.php.

44.62 - Density Measurements and Recording

If measurements are taken in conjunction with the beltline tapes as described in section 44.16, measurements are taken along the whole 100-foot belt of each line, within 3 feet of one side of the belt. This creates a sample area 100 feet long and 3 feet wide. A similar type study area can be independently set up if measurements are not made in conjunction with normal spoken wheel belts.

All shrubs (or measured plants) encountered along the belt transect are tallied by species and classified according to form and age class. The electronic density PDR form is used to record this information. Shrub age and form observations taken by a staked line transect (Cole Browse Survey Method) may also be recorded. When not using the frequency layout, take shrub age and form along a staked transect. Beginning at the starting stake the nearest selected browse plant is sampled and age and form class is recorded. The next plant sampled is the closest plant past the one just sampled within a 180 degrees when moving generally down the transect line. Continue this sampling procedure until 25 to 50 browse plants have been recorded. If the browse stand is not dense, select and sample plants at a paced interval (for example, 5 paces, 1/2 chain, and so forth) in the transect direction and select the nearest plant in a 180 degree zone.

44.63 - Age Classes

To assure consistency in classifying and recording shrubs by form and age class use the following definitions:

1. Seedling (Sprouts) (S) - A very young plant that has become firmly established yet obviously is a newcomer on the site (first-year seedlings are ignored). It is usually distinguished by its relatively small size, generally single stem, simple or no branching, succulent bark, less than 1/8-inch diameter at the base, and does not possess a large root stock (sprouts may be an exception). No evidence of flowering or seed production.

2. Young (Y) - A relatively young plant, larger than a sprout or seedling (1/8-inch to 1/2-inch diameter at the base, varying with species) with more complex branching, may possess multiple basal stems but are attached to a relatively small root stock (except for saplings), and bark is more fibrous but is not fissured as with a mature plant. Crowns are not rounded and are made up of all living wood. May or may not show signs of flowering and seed production.

3. Mature (M) - A mature plant exhibits complex branching and multiple stems, fibrous fissured bark, rounded growth form, large, heavy, often gnarled stems and a firmly established predominant root stock. The root crown is made up of three-quarters or more living wood. Evidence of flowering and or seed production is present.

4. Decadent (D) - A mature plant which possesses more than 50 percent dead wood in the crown.

5. Dead (X) - A plant which obviously does not possess any live crown, but the root is still firmly attached (downed, unattached, woody stems are considered litter).

44.64 - Form Classes

The form classes are based on availability of browse plants and their degree of hedging. These factors along with age structure can assist in determining the relative health of a browse stand and can aid in evaluating trend.

Availability represents the relative amount of twig growth that is within reach of grazing animals. Snow depth or duration will have no bearing on availability, as defined in this Handbook. Hedging is the result of repeated utilization and is one of the factors that affect availability of shrubs. The general appearance of the plant is a primary criterion in determining degree of hedging.

The following explanations are provided as an aid to classifying shrub availability.

1. All available. This category signifies that all of the current year's twig growth is within reach of grazing animals. An open crown generally represents this type of plant.

2. Largely available. The bulk of the vegetation in this category is available to the class of herbivores present in the area. A small portion of the current year's growth is unavailable due to:

   a. Large crowns.

   b. Moderate to heavy hedging.

   c. Shrubs height.

   d. Steep terrain.

   e. Stand density.

3. Mostly unavailable. A large portion of current year's growth is not available for grazing. This may be due to one or more of the reasons mentioned in the largely available category above.

4. Unavailable. These shrubs may produce large quantities of twig growth; however, it is not available to grazing animals. Frequently, a tall growth form places shrubs in this category. A hedgeline is also common where shrubs have become unavailable. Dead or decadent plants often fall in this category.

44.65 - Hedging Categories

1. Lightly hedged. Shrubs of this nature generally have open, loose crowns and produce a large quantity of vigorous twigs. Frequently, these plants are either all or largely available. Their appearance is that of healthy, fast-growing plants. Unhedged plants are included here.

2. Moderately hedged. These shrubs possess moderately open crowns but show signs of some clubbing. Plants that are hedged to this degree exhibit varying levels of vigor and begin to take on a ragged appearance. Some of the twigs are readily available while the remaining twig growth is generally unavailable due to the tight growth forms and presence of larger clubbed stems on the periphery of the crown.

3. Closely hedged. A closed, compact rounded appearance is usually characteristic of this degree of hedging on a mature plant. Generally, very little twig growth is present on the exterior portion of the shrub; most of the twig growth is confined to the interior.

A decadent plant often shows signs of close hedging on the few larger stems that produce limited leader growth. Young plants are generally not very common in a closely hedged shrub community.

44.66 - Shrub Density Data Summary

The summary is a total of the tallies per area measured and recorded for each individual species on each transect. These totals can subsequently be compared with previous or subsequent measurements of the same stand.

44.7 – Ocular Plant Composition

Cover is one of the most common measures of community composition because it equalizes the contribution of species that are very small, but abundant, and species that are very large, but few. Of the three measures--density, frequency, and cover--cover is the most directly related to biomass and as such is a good estimate of the ecological influence of a plant in a community.

Cover (area) is widely used in rangeland management. It is the best index of species dominance. The term “cover” is applied to a two-dimensional plan projection of some portion of the plant. It may be basal, where the portion of the plant to consider is (a) attached to or (b) touching the ground surface. This usually is measured one inch above the ground. On the other hand, cover may be aerial, where some view of the above-ground plant material is (mentally) projected to the ground in estimating cover. "Area" often is used synonymously with cover.

Follow protocols and use the form at
http://fsweb.ftcol.wo.fs.fed.us/frs/rangelands/inventory/ocular-plant-composition.php.

45 - RIPARIAN VEGETATION MONITORING

Several inventory, monitoring and evaluation processes are available to gather and monitor intensive vegetation information in riparian areas: Long-trend riparian monitoring methods for the interior West were evaluated in a workshop in Logan, Utah in September 2004; the subsequent report is recommended as an overview on this issue (National Riparian Service Team (NRST) 2004). Four long-term riparian monitoring methods were compared: the Greenline method (Winward 2000, Pacfish/Infish Biological Opinion (PIBO)Riparian vegetation sampling (Coles-Ritchie et al. 2004), Cowley and Burton (2004), and the riparian scorecard method (Zamudio 2005, Weixelmann et al. 2007). The PIBO and Cowley and Burton methods were developed in order to improve on the Greenline method. The riparian scorecard method offers the benefits of soils evaluation and suitability for sampling in methods, at the cost of additional sampling time.

At this time, any of these four methods are acceptable for monitoring. As the 2004 meeting (NRST 2004) indicated, methods are still being evaluated, and recommendations may change in the future. (Note this handbook is planned as an 18-month document.) As the riparian scorecard method receives further peer review and is published, its credibility as a standard method will be enhanced.

The Greenline, PIBO, and Cowley and Burton methods have been well documented (see literature citations above). Following is a brief synopsis of the riparian scorecard method. More details can be found in Zamudio 2005 (a draft report) and Weixelmann et al. 1997.

Riparian scorecard

An intensive riparian sampling method suitable for long-term trend monitoring has been developed by Zamudio (2005) and others of the Central Oregon Ecology Service Team (see also Weixelmann et al. 1997).. This method is the most intensive of those listed, and should be seen as a long-term investment in monitoring, and be reserved for only those areas of great management interest or controversy. It involves mapping and classification of riparian zones, and then monitoring vegetation and soils within those zones over time. Steps in the riparian scorecard process are:

1. Clearly articulate the issues and objectives the method will be addressing.
2. Identify study areas. Ensure they are relevant to the questions being asked.
3. Identify the landscape and vegetation/ecological type classification, creating a new classification if previous ones are not available.
4. Select location of monitoring transects with quadrats. Locations should be selected to monitor plant growth conditions and seral stability within each type. Data collected include plan composition, vigor, and root masses (Zamudio 2005), as well as the soil features of a profile description and water infiltration rate.

Outputs include a comprehensive look at the seral stages within ecological types, and how well they can be considered to be functioning. The monitoring answers several of the seral and functional questions in the extensive riparian proper functioning condition method (Prichard et al. 1998).

46 - DATA EVALUATION

Use Chi-Square analysis statistical method for most analysis to determine if a significant change has been made in the parameter measured from one measurement to another. This statistical method can be used with nested frequency, line intercept, ground cover, and shrub density. Other optional statistical methods that could be used are Duncan's multiple range analysis, analysis of variance, and discriminate analysis. See exhibit 46.1 - Evaluation of Frequency Data

Total the data from all five beltlines. Each species can then be compared with previous readings and evaluated using Chi Square to determine if the change between measurements is significant. At least two readings are needed in order to use this statistical evaluation. The Chi Square table for determining if there is a significant change, at the 80-percent probability for an individual plant whose frequency is summed from all five transects, is located in section 46 exhibit 01.

Using Chi Square in exhibit 1, the initial frequency value is the number of plots in which a particular species occurs. If there has been a decrease in the frequency of occurrence from the initial observation, the column to the left is used to determine whether the decrease has been significant at the 80-percent probability level. The column to the right of the initial observation is used if the second observation has increased from that of the initial observation. If the change has been significant at the 80-percent probability level, the second value will be equal to or be larger than that listed. These values are actual observed values, that is, the sum of the plot values in all 400 plots from all 5 belts. Only in situations where there are 400 plots observed is the number of occurrences and the percentage value the same. With a densely populated species it is possible to have a maximum value of 400, based on 100-frame settings (5 belts times 20 frames/belt) and the species could occur in plot 4 in all frames. The table has been developed for such a possibility.

For example, a particular species had a summed value of 42 in the first sample. At a subsequent sampling, the summed plot value was 30. This reduction would be significant at the 80-percent probability level because the second reading was equal to or less than 32. To detect a significant increase from the original value of 42, the second reading would need to be 52 or greater.

The Chi Square calculations are based on the equation:

$$\frac{(E - 0 - 0.5)^2}{E} = \text{Chi Square}$$

Where: E is the initial number of occurrences
0 is the number of occurrences in the second observation
0.5 is a correction value for observations fewer than 200-plot placements.
The Chi Square value at 1 degree of freedom @ 80 percent probability is 1.642.

Statistical analysis shows when a significant change occurs between different vegetative measurements. When that measurement method is frequency, one or more vegetative parameters could have changed (density, cover, or spatial distribution). When a frequency change is recorded, the manager must still determine what changed and why.

46.2 - Cover and Density Evaluation

Evaluate ground cover, bare soil, line intercept, and shrub density using the same approach and table as given for frequency. A maximum total of 400 measurement units would be possible for bare soil or vegetation.

46 - Exhibit 01

CHI SQUARE TABLE

Table for determination of significant increase or decrease in plot occurrences (nested frequency) at 80 percent probability (Chi Square = 1.642, with 1 degree of freedom).

LESS THAN	INITIAL VALUE	GREATER THAN	LESS THAN	INITIAL VALUE	GREATER THAN	LESS THAN	INITIAL VALUE	GREATER THAN
14	22	28	58	71	82	180	200	218
15	23	29	59	72	83	185	205	223
16	24	30	60	73	84	189	210	229
17	25	31	61	74	85	194	215	234
18	26	33	62	75	86	219	220	239
19	27	34	63	76	87	204	225	244
19	28	35	64	77	88	209	230	249
20	29	36	65	78	89	213	235	255
21	30	37	66	79	90	218	240	260
22	31	38	67	80	91	223	245	265
23	32	39	67	81	93	228	250	270
24	33	40	68	82	94	233	255	275
25	34	41	69	83	95	237	260	281
25	35	43	70	84	96	242	265	286
26	36	44	71	85	97	247	270	291
27	37	45	72	86	98	252	275	296
28	38	46	73	87	99	257	280	301
29	39	47	74	88	100	261	285	307
30	40	48	75	89	101	266	290	312
31	41	49	76	90	102	271	295	317
32	42	51	77	91	103	276	300	322
33	43	51	78	92	104	281	305	327
34	44	52	79	93	105	285	310	333
34	45	54	80	94	106	290	315	338
35	46	55	81	95	107	295	320	343
36	47	56	81	96	109	300	325	348
37	48	57	82	97	110	307	330	353
38	49	58	83	98	111	309	335	359
39	50	59	84	99	112	314	340	364
40	51	60	85	100	113	319	345	369
41	52	61	90	105	118	324	350	374
42	53	62	95	110	123	329	355	379
43	54	63	99	115	129	334	360	384
43	55	65	104	120	134	339	365	389
44	56	66	109	125	139	343	370	395
45	57	67	113	130	145	348	375	*
46	58	68	118	135	150	353	380	*
47	59	69	123	140	155	358	385	*
48	60	70	128	145	160	363	390	*
49	61	71	132	150	166	368	395	*
50	62	72	137	155	171	372	400	*
51	63	73	142	160	176			
52	64	74	147	165	181			
53	65	75	151	170	187			
54	66	76	156	175	192			
55	67	77	161	180	197			
55	68	79	166	185	202			
56	69	80	170	190	208			
57	70	81	175	195	213			